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CONTENTS

Multiplex Telephony and Telegraphy over Open-circuit Bare Wires laid in the Earth or Sea: MAJOR GENERAL GEORGE O. SQUIER. 445

Research in the Psychology of Aviation during the Year 1919: CAPTAIN HARRY M. JOHNSON 449

General Biology and the Junior College: PROFESSORS LEONAS L. BURLINGAME AND ERNEST G. MARTIN 452

Francis C. Phillips: PROFESSOR ALEXANDER SILVERMAN 455

Scientific Events:—
Bird-banding Work being taken over by the Biological Survey; The Pacific Coast Division of the American Association for the Advancement of Science; The Resignation of the Director of the Bureau of Mines; The Resignation of Professor E. L. Nichols from the Yale University Faculty; The Allegheny Observatory 456

Scientific Notes and News 459

University and Educational News 462

Discussion and Correspondence:—
Singing Sands: ALBERT R. LEDOUX. *Modern Interpretation of Differentials:* PROFESSOR ARTHUR S. HATHAWAY. *Carbon Dioxide and Increased Crop Production:* PROFESSOR BENJAMIN HARROW. *Structural Blue in Snow:* DR. JEROME ALEXANDER 462

Scientific Books:—
Haskell on Graphic Charts: DR. R. VON HUHN 466

Special Articles:—
The Heredity of Susceptibility to a Transplantable Sarcoma of the Japanese Waltzing Mouse: DR. C. C. LITTLE 467

The American Association of Petroleum Geologists 468

The American Association for the Advancement of Science:—
Minutes of the Executive Committee of the Council: PROFESSOR BURTON E. LIVINGSTON. 470

MSS. intended for publication and books, etc., intended for review should be sent to The Editor of Science, Garrison-on-Hudson, N. Y.

MULTIPLEX TELEPHONY AND TELEGRAPHY OVER OPEN-CIRCUIT BARE WIRES LAID IN THE EARTH OR SEA[1]

INTRODUCTION

THE "key problem" in the procurement of essential Signal Corps supplies in the United States during the World War, curiously enough turned out to be the production of the necessary braiding machines for finishing insulated wire. The bare wire itself could be obtained, the rubber insulation could be obtained, even the cotton thread with which the braiding was made could be obtained, but the necessary machinery for braiding the thread, which finally led us into the intricacies of the procurement of steel, was never anything like adequate for the enormous demands required in the field.

The braiding capacity of the entire United States, as of September 1, 1918, was about 8,000 miles of twisted pair insulated wire per month, while the requirements for the American forces alone at that date were about 40,000 miles a month. On October 1, 1918, the Allied Council reached the decision that beginning March 1, 1919, it would be necessary for the United States to furnish all of this type of wire used by the Allied armies in the field, and the estimated minimum requirements for this purpose were equivalent to four times around the earth a month. To supply this amount of insulated wire would have required cargo space for overseas

[1] Abstract of paper presented to the National Academy of Sciences at the session held at the National Museum, April 27, 1920.

shipment in the amount of 14,000 ship tons a month, but had it been possible to use single conductor bare wire in place of the twisted pair insulated wire, the space required would have been reduced to 2,500 ship tons a month, thus releasing the balance for transportation of food, and other vitally necessary supplies.

It is therefore of paramount importance to diagnose, as far as possible, the technical problems of equipment in the light of past experience and of the present trend of development.

The above facts show the necessity of developing, if possible, new methods by which a reduction may be effected in the enormous quantities of expensive and bulky insulated wire, which was so difficult to procure, and which must now be buried in the earth to a depth of 8 or 10 feet throughout the advance sectors of the front line of a modern army.

THREE MEDIA FOR ELECTRIC WAVE PROPAGATION

The following reasoning led to the carrying out of the experiments to be described:

1. Since we can already communicate by radio means between one submarine and another submarine, both completely submerged, it was considered that connecting two such stations by a submerged copper wire could have no other effect than to facilitate the propagation of the electric waves between the stations.

2. It was considered possible that the behavior of earth or water under the action of high frequency currents might exhibit greatly different properties from those with which we are familiar at direct or low frequency currents.

3. It was realized that whatever high frequency energy losses might occur in the case of bare wires laid in earth or water, yet the over-all efficiency would be higher than in the case of radio space transmission where the plant efficiency is so very low.

4. It was noted by the writer in September, 1910, and discussed by him in April, 1912,[2] that the three-electrode audion could be used as a potentially operated device on open circuits. This arrangement was considered suitable for the reception of the signals over bare wires in earth or water.

PRELIMINARY EXPERIMENTS

The first experiment was an extremely simple one as follows: A bare No. 18 phosphor bronze wire, such as is used for the Signal Corps field antenna, was laid across the Washington Channel of the Potomac River from the War College to the opposite shore in Potomac Park. It was paid out from a small boat with sufficient slack to lay on the bottom of the river. A standard Signal Corps radio telephone and telegraph set, SCR 76, was directly connected to each end of the wire, one set serving as a transmitter and the other as a receiver. At the receiving end of the line the bare wire was directly connected to the grid of the receiving set and the usual ground connection left open. A frequency of about 600,000 cycles a second was used and the line tuned at each end by the usual methods. Excellent telegraphy and telephony were obtained. Care was taken to make this preliminary experiment as simple and basic as possible and precaution taken to insure that the wire itself should be bright and clean entirely free from any grease or other insulating material.

[2] *Journal of The Franklin Institute*, April 1, 1912, "Some Experiments in 'Wired Wireless' Telegraphy for Field Lines of Information for Military Purposes," by Major George O. Squier, Signal Corps, U. S. Army.

The success of this simple experiment immediately led to more thorough consideration of the entire subject.

One of the questions to be investigated was the general efficiency of the electron tube when used as a potentially operated instrument. The following experiment was made:

A strip of wire netting was buried in the snow outside the office of the Chief Signal Officer in Washington and a wire attached thereto leading to the second story of the building. The upper end of this wire was connected directly to the grid of an electron tube. The reason for connecting the grid to the upper end of the antenna is of course obvious if we are to use the tube as a potentially operated device. It was necessary for maximum sensitiveness to connect it to the point of maximum potential of the antenna which in the case of a linear oscillator occurs at the open end. By this arrangement, messages were readily received from distant points in the United States.

These two simple experiments, above described, demonstrated the possibility of transmitting electromagnetic waves along bare wires submerged in water and the use of an electron tube as a potentially operated device for the reception of signals. The technical data will be published later.

SUMMARY

For military reasons, if for no other, as stated in the introduction of this paper, the Signal Corps has recently undertaken certain investigations in the phenomena connected with the transmission of high frequency electromagnetic waves over bare wires in earth and in water.

In carrying out these investigations and in attacking the problems from various angles, the research staff of the Signal Corps laboratory at Camp Alfred Vail, Little Silver, New Jersey, was directed to carry out experiments on bare wires laid on the surface of moist ground and also buried in earth. The staff at the Signal Corps research laboratory at the Bureau of Standards was directed to investigate fundamentally the transmission of electromagnetic waves over bare wires in fresh water. In addition to this, the engineering staff of the Office of the Chief Signal Officer has carried out from time to time certain experiments of a more or less crucial character which have come up for solution in the prosecution of this work at the other laboratories.

Certain data from each of these groups of engineers have been presented above. The phenomena associated with the transmission of high frequency waves over bare wires in earth or water are obscure and complex, and the writer has formulated no definite theory at the present time.

RESULTS OBTAINED

1. Telephone and telegraph communication has been established between Fort Washington, Maryland, and Fort Hunt, Virginia, across the Potomac River, below the city of Washington, over a distance of about three quarters of a mile, by the use of a bare No. 12 phosphor bronze wire laid in the water to connect the stations. The transmitter consisted of an electron tube oscillator which delivered a current of about 270 milliamperes to the line at a frequency of about 600,000 cycles a second. At the receiving end of the line an electron tube and a 6-stage amplifier were used without any ground connection. With this arrangement good tuning was obtained at both ends of the line, and telegraphic and telephonic transmission secured over the bare wires immersed in fresh water.

2. A resonance wave coil has been devel-

oped. The coil is in the form of a long helix wound with a large number of turns on which stationary waves are produced by the incoming radio signals. An electron tube is used as the detector, the grid being connected to the point of maximum potential on the coil. The wave coil may be used either as a part of the usual antenna system or a part of a line wire, or it may act itself as the antenna for picking up the energy of the signals. In the latter case the coil may be either free at both ends or grounded at one end. Good results have been obtained in either case. It has been also found that the open coil has directional properties and can be used as a goniometer not only for horizontal measurements but for vertical measurements as well. This form of radio goniometer has the great advantage that it permits not only of determining the plane where the signals are strongest but also the direction from which such signals proceed.

Telegraph and telephone communication has been also established between two stations at the Signal Corps Research Laboratories at Camp Alfred Vail, Little Silver, New Jersey, using a bare No. 16 copper wire buried in the earth to a depth of about eight inches to connect the stations. The distance between the two stations was three quarters of a mile. Frequencies as high as one million cycles a second were used. Similar communication has been carried on over a bare wire one and three quarter miles long laid on the surface of moist earth. The current at the transmitting station in these installations was about 100 milliamperes. It has been shown that a bare wire buried in moist earth with the distant end open can be tuned both at the transmitting end and at the receiving end.

SUGGESTIONS

1. In the older art of ocean telegraphy, the elaborateness of line construction has already reached a practical limit. The best Atlantic cable of the present day is limited in operation to electric waves of frequency of the order of magnitude of 10 per second. The electrical construction is such as to limit the voltage employed on any long cable to from 50 to 80. The relative values of the line constants in any ocean cable preclude the possibility of ocean telephony.

The most promising hope of improving the line construction for ocean cables is believed to be, to abandon the present method of design and construction and to start with the simple case of bare wires in water using high frequency currents and study the necessary changes to produce optimum transmission.

The use of a high frequency "carrier" has the inherent advantage that the distortion phenomena accompanying present methods of long distance transmission are eliminated, and we are principally concerned with the problem of reducing attenuation. The most suitable voltage may be employed and present multiplex methods may be utilized. The electron tube is available for both the generation and the reception of the waves.

2. During the last few years an intensive study has been made of the surface conditions of wires necessary to produce the emission of electrons, and to this intensive study, both by universities and industrial research laboratories, is due the high state of efficiency of the present electron tube. Nothing short of a similar study of the surface conditions of wires for preventing the emission of electrons instead of producing them, will finally give us the wire conductor of the future.

3. The development of types of reson-

ance wave coils, both open at one end and at both ends, for general radio work offers an interesting field for investigation. This involves the study of the electron tube as a potentially operated device. The application of such coils properly designed for specific purposes may lead to the practical solution of a number of radio problems such as directional effects, and wave coils antennæ of very small dimensions.

4. The account of the experiments thus far conducted and the reasons which have led to the undertaking of these experiments on the part of the Signal Corps, are presented to the National Academy of Sciences at this time in conformity with the new spirit of organization for national and international research so admirably typified by the National Research Council which is under the general direction of this official body.

GEORGE O. SQUIER

OFFICE OF THE CHIEF SIGNAL OFFICER,
WAR DEPARTMENT,
WASHINGTON, D. C.

RÉSUMÉ OF RESEARCH IN THE PSYCHOLOGY OF AVIATION DURING THE YEAR 1919

THE writer has been in charge of the department of psychology of the Air Service Medical Research Laboratory since January 15, 1919. Members of the department engaged in research during that year included Drs. F. C. Dockeray, D. C. Rogers, H. C. McComas and J. E. Coover, as captains; Dr. English Bagby and Mr. Schachne Isaacs, as lieutenants; and Dr. F. C. Paschal, Miss Barbara V. Deyo and Mrs. Cressie Campbell Merriman, as assistants. Certain members of the group were present for but a short time; and others were present for several months. Dr. E. N. Henderson and Mr. L. J. O'Rourke, as captain and lieutenant, resepctively, were connected with the department for some time, but the exigencies of the service did not permit of their employment in research. Since October last the staff has consisted of Lieutenant Isaacs and the writer, with Miss Deyo and Mrs. Merriman as research assistants.

During the year the department prosecuted research along two distinct and independent lines: (1) an effort to gain a somewhat more intimate acquaintance with the effects of low oxygen on the integrity of response; and (2) an effort to develop more sensitive tests for the detection of (*a*) general aptitude for aviation work and (*b*) of its deterioration in the earlier stages of staleness. The reports of this work will probably appear in due time in the various American psychological journals, under the names of the authors who are individually or jointly responsible. Meanwhile, a résumé of the year's activities of the department as an organization may not be out of place here.

An extensive and detailed statistical study of the records of over 6,000 classification-tests for resistance to deprivation of oxygen, has been made under the direction of Captain Coover. He was assisted by Lieutenant Isaacs, Dr. Paschal, Miss Deyo, Mrs. Merriman and the writer. The results indicate the extent to which the subject's performance may be affected by atmospheric pressure, temperature and humidity; by the absolute quantity of oxygen supplied the subject in the air to be rebreathed; by the duration of the test; by the time of day at which the test is taken; by the judgmental eccentricities of the psychological and clinical observers; and by a lowered morale, such as that which immediately followed the armistice. With these data available it is now possible, by controlling or correcting for the influence of these variables, to approximate much more closely to uniformity and constancy of the standards of classification than has been possible hitherto.

An attempt was made by the writer, in collaboration with Dr. Paschal, to demonstrate the progress of impairment of behavior by the use of an objective record of the speed and accuracy which the subject can maintain in carrying on work of uniform difficulty as the supply of oxygen is being diminished.

(The subject was required to encipher a number of sets of nonsense-material into specially prepared codes, both the material and the ciphers being selected for uniformity in the distribution of difficulties.) Some interesting records were obtained, which, however, do not give the quantitative measure of impairment which the appearance of the graphs suggests. One reason for this fact is that many subjects tend to compensate for impairment of response by an increase of "voluntary" effort. The fact can be noted by the observer, and such clinical notes are necessary to correct interpretation of the "quantitative" data.

Some tests on the fluctuations of visual acuity over extended periods of observation were made by the writer, using in general the method described by Cobb;[1] the test-field, however being a real image of the pattern of the Ives-Cobb visual acuity test-object, slightly magnified on one half and slightly reduced on the other, projected into the plane of an opening in a screen 60 cm. from the eye. Some results thus obtained were not fully expected; *e. g.*, (1) it appeared that fixation and accommodation upon a stationary object can be maintained until the last stages of asphyxiation have been reached; (2) that disturbance of the visual function is not exhibited by this type of test until the more highly coordinated processes have actually begun to fail; and (3) that in the last stages of asphyxiation, visual impressions may become intermittent and the entire field become darkened, without the outlines of objects appearing blurred, and without diplopia developing under the conditions of this particular test. It should be remarked, however, that these conditions are much less trying than those which compel coordinated eye-movements to be executed within a limited time; and that the latter conditions often elicit and exhibit marked disturbances. This work will probably be carried farther.

Dr. Rogers perfected an attachment for the Henderson rebreather by means of which the rate of diminution of oxygen can be controlled, within reasonable limits, through the replacement of a known proportion of the oxygen consumed within a given time. The apparatus is considered superior in some respects to one previously used in another department, and its employment assures that different subjects can be made to experience comparable degrees of oxygen-hunger for comparable times.

An investigation was made by Dr. McComas on the influence of diminished air-pressure, simulating an altitude of 20,000 feet, on the time required for selective reaction to a number of combinations of signals visually perceived. The experiment being exploratory in character, and the time of the experimenter being limited, it was not feasible to introduce certain controls which otherwise would have been desirable. However, the data as obtained indicate that the time required for selective response is greatly lengthened and its variability increased, by the abnormal conditions of the experiment, until the subject by continued practise has rendered his responses almost purely mechanical. The results obtained in the later stages of training are open to more than one interpretation, and it is planned to resume experimentation as soon as may be practicable.

Dr. Bagby made a systematic contribution in the form of a study entitled "A psychological point of view in psychiatry, with special reference to pathological behavior under deprivation of oxygen." This report calls attention to manifestations of emotional instability which sometimes occur during the rebreathing test in the absence of adequate external stimuli. The display under such conditions of anger, fear, destructiveness, excessive nonchalance, silliness and euphoria, is compared with symptoms of alcoholic intoxication, and with characteristic symptoms of certain types of insanity. The opportunity incidentally afforded by the test, of observing evidences of lack of poise which are not necessarily prominent in the normal state, is emphasized.

A study of associative responses was begun

[1] Cobb, P. W., "The Influence of Pupillary Diameter on Visual Acuity," *Am. Jour. Physiol.*, 1915, Vol. XXXVI., pp. 335–346.

during the summer by Dr. Bagby, for the purpose of exhibiting the extent to which pathological reactive tendencies, existing normally in a state of repression, tend to be released under diminished barometric pressures corresponding to fairly high altitudes. The author was separated from the service before the work was completed, but not until after an excellent collection of test-material had been compiled and tested. Arrangements have been made to have the work completed by Lieutenant Isaacs, as soon as the low pressure chamber has been installed in its new location.

The results of the tests of aptitude for flying, administered by Drs. McComas and Bagby at Taylor and Souther fields under the direction of Major Stratton in 1918, were worked up in the department under the direction of Dr. Coover, with the assistance of several members of the staff. The data indicate that the tests taken as a group have some diagnostic value and that certain of the individual tests if further refined may have considerable practical value. An important fact exhibited by the data is that flying grades do not adequately differentiate aviational ability. About 85 per cent. of the cadets tested at one field was rated within a range of five points on a scale of 100. This means, practically, that a certain grade was taken as expressing the rating "Fairly good," for example; and that practically all the men so regarded received the same grade, no means being provided for ranking them *within* the class within which they fall. This makes a comparison of flying grade with other scores, quite difficult of interpretation.

The results of a number of tests of aviational ability used by Captain Dockeray and Lieutenant Isaacs in the A. E. F. were worked up by those authors here. The data show that the scores of the subjects in two of the tests are highly correlated with the estimate of aviational ability as made by the training department, the coefficients in both cases being approximately 0.73. It is safe to say that if six to eight tests as satisfactory as these were developed, they would afford a better basis of prediction of flying-school performance than is afforded by the cadets' records in civil life, or by their performance in ground school, etc. It is planned to continue the effort to develop such tests.

Preliminary work in the department suggested that two forms of test, if sufficiently refined, might prove to be quite valuable in diagnosis of aviational ability and in exhibiting its impairment. These tests are (1) of the ability to control the coordinated activity of certain systems of voluntary muscles; and (2) of the *relative* time required for selective reaction to one of three signals presented successively and in irregular sequence (*a*) under a standard condition of observation and (*b*) under a condition of observation so difficult as to be trying. This work is still in the early stages, due largely to the delay in making the annual appropriation available, and to the general disorganization and turmoil incidental to the closing of Hazelhurst Field and moving the laboratory hither.

In addition to the research activities recapitulated above, some considerable energy of the department was devoted to supervision of the psychological features of the routine tests run at branch laboratories; to the administration of classification-tests at the local fields; and to cooperation with other departments in the administration of tests in which the department of psychology was not directly interested.

Courses in psychology were given to three classes of military physicians in training for the work of flight surgeons. These courses covered: fundamental presuppositions of the science of psychology as defined by the more prominent contemporary authors; the rudiments of psychophysical methods and technique; an introduction to elementary statistics, including measures of central tendencies, variability and correlation; the psychological features of the classification-tests used in the Air Service; and an introduction to the concept of the wish as a unit in behavior. While most of these students made quite a creditable showing it has since been deemed advisable to discontinue the work in statistics

and to substitute for it work bearing directly on the "personality study" which these physicians are required to make of their wards.

Harry M. Johnson,
Sanitary Corps.
Mitchel Field, L. I., N. Y.

GENERAL BIOLOGY AND THE JUNIOR COLLEGE

Biologists are much indebted to Professor Nichols for his excellent summary of sentiment in respect to the so-called "General Biology" course. His survey would appear to indicate that possibly a majority of biologists believe that a year's work, consisting of a half year each of introductory botany and zoology, is general biology or is at least a preferable substitute for it. In a recent article Professor Henderson expresses his dissent from this view and raises the question of the relation of this course to general culture and the junior college. He says:

> I take it as axiomatic that there is a certain minimum of information regarding matters biological which every educated man ought to have . . .

and

> It seems—at least some of us hope—that to-day we are about to see a displacement of the academic course in favor of the junior college, which would give such general subjects as the languages, American history, elementary chemistry and physics, and the one or two other things which every one should have; . . .

The Junior College.—That there is already a strong current of sentiment toward the junior college is a fact of which one can scarcely remain unaware. For this there appear to be several reasons. In the first place many of the larger universities are fairly swamped with students of immature age in respect to the nature and content of the courses offered them. A second and possibly more important reason is that such junior colleges can be established and maintained in most larger towns and cities. This results in a desirable saving in expense to the student. Its chief advantage to the university lies in the fact that it frees it from overcrowding and acts as a desirable preliminary period during which there is likely to occur a sorting out of the students better qualified by ability and interest to pursue the professional courses of the university.

In the third place our universities are showing stronger and stronger tendencies away from "general culture" courses. To the small college is left, in large measure, the task of imparting general culture. Modern education consists, then, either in a series of years devoted wholly to general culture, or in an equal period of specialized, more or less technical study, the determining factor being whether the student happened to attend a small college or one of the larger universities. The exigencies of modern life forbid, in the case of many individuals, and render of doubtful value for others, the spending of four years in acquiring general culture. On the other hand, a curriculum devoted wholly to specialized training is thought by many intelligent persons not to afford a liberal education, at least in the best sense of that term. The junior college offers a feasible, if not an ideal, solution of the difficulty by allowing (or perhaps requiring) two years of general culture on which may be superposed two or more of specialized training.

An important feature of the junior college which commends it to many is the limited election which its organization permits. The immature student may well be compelled to form acquaintance in an elementary way with the subject matter of the chief lines of human endeavor, and, what is more important, with the point of view and habits of thought of workers along these lines. Too free a range of election in the earlier years hinders this attainment of broad outlook by tempting the student to follow along familiar pathways. With distressing frequency is the spectacle presented of students clinging to certain groups of courses because they feel reasonably sure of success therein, whereas their own best educational interests demand that they venture into strange fields and feed on untried pabulum.

Whether the first two college years are given on the university campus or in a separate junior college it seems highly desirable to reconsider the nature and content of their courses. As matters now stand in the larger institutions there are likely to be from twenty to thirty separate departments of instruction, each of which offers an elementary course introductory to its particular field of investigation. Under these circumstances the student finds it difficult or impossible to acquire a *general knowledge* of the fields of human endeavor. It is true, of course, that most departments aim so to construct their introductory courses as to make them suitable foundations for further and more specialized work and at the same time afford as much general information and training as possible. The truth, in the opinion of many, is that this double object is very difficult, or perhaps impossible, of satisfactory achievement. It is the old, old problem of serving two masters and usually with "General Culture" cast for the rôle of Mammon. The general result is that there are numerous excellent courses in every university, considered from the point of view of introductions to their respective subjects, but very few general culture courses worthy the name. But even granting that some do achieve this two-fold object and that all might do so, it still remains true that the student must take too many courses to secure what he desires and must learn many specialized facts and acquire special technique which he neither ardently desires nor particularly needs.

If, now, the case against the growing extreme specialization in the first two college years has been fairly put, we are faced with the problem of attempting a resynthesis of the subject matter of elementary courses which will at once reduce the number of courses and broaden their outlook. The chief aim should be to remove them from the field of specialization to that of general culture; to make them fit into the general educational scheme of the genuinely well-educated man. However, sight must not be lost wholly of the fact that these junior college courses will constitute, also, the collegiate introduction, in some cases, to the specialized lines of study to be pursued later. To be specific, the general biology course must not only present a broad view of the field of biology to the general culture student but should also make clear to the future physician, agriculturist, or scientific investigator the relation of his special field of effort to that larger domain of which it is but a specialized part.

Before considering the specific application of these general ideas to the question of elementary instruction in biology it seems desirable to raise and discuss two preliminary inquiries: (1) What is wrong with the "General Biology" courses of the past? (2) Why are the usual consecutive courses in botany and zoology regarded as unsatisfactory?

The Case against "General Biology."—Careful reading of Professor Nichols's paper shows that the objections to general biology are directed, for the most part, against the "standard" course, based originally on the text-book of Huxley and Martin; but with an undercurrent of opinion that no course can avoid certain pitfalls, among which are: the difficulty of finding men of sufficient breadth of view to give general biology adequate presentation; the equally serious difficulty of finding zoologists and botanists who can cooperate harmoniously in giving a course jointly; the danger that abstract principles may be stressed unduly, to the exclusion of concrete facts; and finally, the alleged unsuitability of general biology as an introduction to further study of zoology or botany. Disregarding, as we should, those objections that are based on interdepartmental or interprofessional jealousies, and assuming, as we may, that zoologists and botanists will cooperate willingly, if the need for such cooperation becomes clear, the problem boils down to the question whether a "General Biology" course properly designed to afford a maximum of general culture would also be a useful and desirable introduction to his field for the future botanist, zoologist, or physician.

Objections to Consecutive Courses in Botany and Zoology.—Consecutive courses usually are

not, and generally are not intended to be, adequate presentations of general biology. On the contrary these courses are commonly admirable introductions to the sort of botany or zoology taught in their respective institutions. They are open to criticism from two directions. In the first place they contain much that is of little interest or importance to the general culture student and they usually involve an excessive amount of detailed laboratory work for this type of student. We do not mean to assert that a thorough training in the laboratory is not good for any sort of student but merely to point out the absurdity of compelling him to acquire a different one for each field of study if he is to become a really well educated man. Not unnaturally the majority of students, under a system of relative freedom of election, decline to attempt to secure a general education at this exorbitant price.

On the other hand these courses are seriously deficient, from this point of view, in what they omit. This is more serious than the inclusions, for one may reasonably be willing to pay an excessive price for a worthwhile article but he can hardly be expected to be satisfied to pay for what he ardently wishes and really needs and then not get it, even after being overcharged.

Furthermore this criticism comes not alone from the general culture student but also from one of the largest groups of biologists, namely, the medical students. The tandem arrangement has never been satisfactory to them, and now, with the increasing pressure upon their time for technical zoological courses, such as comparative anatomy, becomes virtually impossible. The present situation is that the prospective medical student takes no botany at all, or does so only at the sacrifice of valuable and important non-scientific study, of which he obtains at best far too little. And furthermore, whether he studies botany or not, he goes through his course without having had formal opportunity to acquire a broad conception of life itself and the interrelations of living things with one another and with the inorganic world.

What is General Biology.—To the writers it seems clear that it does not consist in some zoology and some botany, whether administered in the old-fashioned mixture, improperly called general biology, or in the more modern separate dose method of consecutive courses. To us it seems axiomatic that it must have a much broader outlook and that it must in a general way include somewhat the following topics: (1) The structures and functions common to all living things; (2) The distinguishing characteristics of plants as such and their function in the world; (3) The essential characters of animals; (4) The interrelations of plants and animals with one another and with inorganic nature, with special reference to competition, survival, injury, death, disease, and decomposition; (5) The processes of nature whereby matter and energy are so conserved and transformed as to permit the ceaseless and indefinitely continuous round of life. To be more specific this means a study of: (*a*) Protoplasm—its structure and functions, cells, cell division, colonial and multicellular organisms, growth and differentiation; (*b*) the rôle of green plants in the transformation of the free energy of sunlight and simple inorganic compounds into complex energy-containing organic compounds to be used as foods—*i. e.*, as sources of energy and building materials—by animals and non-green plant cells; (*c*) how these foods are used by animals in growth and work and how they produce wastes, eventually to be used again by plants; (*d*) the sensitivity of protoplasm and its rôle in relating the plant and animal to their environment; (*e*) growth and reproduction; (*f*) heredity and evolution; (*g*) disease and death; (*h*) decomposition, putrefaction, and fermentation and other processes in the soil that render organic materials again usable by green plants; (*i*) the transformations and conservation of matter and energy as exemplified in the carbon, nitrogen, and other organic cycles.

Administrative Difficulties.—It seems probable that much of the prejudice against the "General Biology" course has actually had its origin in the inter-departmental friction

of administering a large joint undertaking. We have no doubt that this can be overcome, with patience and good will, even with the present organization of our chief universities. But, on the other hand, these difficulties are greatly minimized under a junior college organization. Presumably in most institutions the first two years work would be placed directly under the control of a dean or other similar administrative officer with little or no departmental bias. He would be empowered and obligated to organize such general courses —General Biology and others—without interference from departments or technical schools, though he would doubtless wisely seek such advice as he needed.

Under a junior college organization, general biology is but one of the urgent needs. A presentation of the general concepts of physics and chemistry is certainly just as much needed and doubtless equally feasible. Certainly the educated man should know something of the earth on which he lives and the planetary system to which it belongs—interesting subject matter for a general course. It is possibly venturing afield for biologists to suggest that a general course could also be devised that would inform the student concerning the human environment in which he lives. What a fascinating course could be made by a serious attempt to set before the student the rôle of the state, the church, labor, capital, eugenics, and euthenics!

In conclusion the writers, a botanist and a physiologist, respectively, would beg to record their conviction not only that a course in general biology, and other similar courses, can be organized and that they are highly desirable but also that the advance of the junior college will shortly force us to attempt it whether we like it or not.

LEONAS L. BURLINGAME,
ERNEST G. MARTIN
STANFORD UNIVERSITY

FRANCIS C. PHILLIPS

DR. FRANCIS CLIFFORD PHILLIPS died at his residence, 144 Ridge Avenue, Ben Avon, Pa., on Monday, February 16, of influenza-pneumonia, passing away in the same peaceful manner which characterized his life.

He was born in Philadelphia, April 2, 1850, the son of William S. and Fredericka Ingersoll Phillips. He received his early education at home from an unusually capable and devoted mother. In 1864 Dr. Phillips studied at the Academy of the Protestant Episcopal Church in Philadelphia and in 1866 entered the University of Pennsylvania, where he obtained his A.B. From 1871–1873 he studied under Regimus Fresenius at Wiesbaden, Germany. During the latter year he was private assistant to Professor Fresenius. He then spent a year at the Polytechnic School at Aachen (Aix-la-Chapelle). Here he was associated with Professor Landolt. Professor Phillips was unable to complete his studies abroad because of the poor health of his father. He returned to America and during the following year became instructor in chemistry at Delaware College. In 1875 he was appointed to the teaching staff of the University of Pittsburgh, then the Western University of Pennsyvania, where he taught for forty years, retiring as head of the Department of Chemistry in 1915. For many years he taught chemistry, geology and mineralogy. Even in the writer's student days (1898–1902) Professor Phillips still taught all branches of chemistry and mineralogy. In 1878–1879 he also lectured to the students in the Pittsburgh College of Pharmacy, where he succeeded the late Professor John W. Langley, a brother of the late Samuel P. Langley, then at the Allegheny Observatory and afterwards secretary of the Smithsonian Institution. In 1879 he received the degree of A.M. from the University of Pennsylvania, and in 1893 the Ph.D.

He was married in 1881 to Sarah Ormsby Phillips daughter of Ormsby Phillips, a former mayor of Allegheny.

In 1915 Dr. Phillips retired from active service in the University of Pittsburgh under the pension system of the Carnegie Foundation. Since that time he had been engaged continuously in research and writing in a laboratory provided by the Mellon Institute. During the recent war he conducted researches

on gases in cooperation with the Gas Warfare Service.

In June, 1919, Dr. Phillips received the honorary degree of Doctor of Science from the University of Pittsburgh.

Dr. Phillips was an authority on natural gas in which field he held international recognition. In 1904 he published the "Methods of Analysis of Ores, Pig Iron and Steel used by the Chemists in the Pittsburgh Region," and in 1913 a text-book of "Chemical German," of which a second edition appeared in 1916. At the time of his death Dr. Phillips had two other books well under way, one on the "Life and Work of Joseph Priestley," the other on "Qualitative Gas Reactions."

Dr. Phillips was a member of the following societies:

Phi Kappa Sigma Fraternity since 1867.
Engineers' Society of Western Pennsylvania since 1880.
American Association for Advancement of Science since 1887.
American Institute of Mining Engineers since 1892.
American Chemical Society since 1894.
American Philosophical Society since 1894.
Phi Lambda Upsilon Fraternity since 1919.

Dr. Phillips was a member of the Chemists' Club of New York City and the University Club of Pittsburgh.

He has been a member of the council of the American Chemical Society since the organization of the Pittsburgh Section in 1903.

Beside his widow, Mrs. Sarah Ormsby Phillips, Dr. Phillips leaves two sons, Clifford S. and Frederick I. Phillips.

Alexander Silverman
School of Chemistry,
University of Pittsburgh

SCIENTIFIC EVENTS

BIRD BANDING WORK BEING TAKEN OVER BY THE BIOLOGICAL SURVEY

The Bureau of Biological Survey at Washington, D. C., has taken over the work formerly carried on under the auspices of the Linnaean Society of New York by the American Bird Banding Association. In taking over this work the bureau feels that it should express the debt that students of ornithology in this country owe to Mr. Howard H. Cleaves for the devotion and success with which he has conducted its investigation up to a point where it has outgrown the possibilities of his personal supervision.

Under plans now being formulated this work will give a great amount of invaluable information concerning the migration and distribution of North American birds which will be of direct service in the administration of the Migratory Bird Treaty Act, as well as of much general scientific interest.

It is desired to develop this work along two principal lines: first, the trapping and banding of waterfowl, especially ducks and geese, on both their breeding and winter grounds; and secondly, the systematic trapping of land birds as initiated by Mr. S. Prentiss Baldwin, the early results of which have been published by him in the *Proceedings* of the Linnæan Society of New York, No. 13, 1919, pp. 23–55. It is planned to enlist the interest and services of volunteer workers, who will undertake to operate and maintain trapping stations throughout the year, banding new birds and recording the data from those previously banded. The results from a series of stations thus operated will undoubtedly give new insight into migration routes; speed of travel during migration; longevity of species; affinity for the same nesting-site year after year; and, in addition, furnish a wealth of information relative to the behavior of the individual, heretofore impossible because of the difficulty of keeping one particular bird under observation.

The details of operation are now receiving close attention, and as soon as possible the issue of bands will be announced, with full information regarding the methods to be followed and the results expected. In the meantime, the Biological Survey will be glad to receive communications from those sufficiently interested and satisfactorily located to engage in this work during their leisure time, for it is obvious that a considerable part must be done by volunteer operators. It is hoped that

a sufficient number will take this up to insure the complete success of the project.

E. W. NELSON,
Chief of Bureau

THE PACIFIC COAST DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE fourth annual convention of the Pacific Coast Division of the American Association for the Advancement of Science will meet at the University of Washington, Seattle, on June 17, to continue three days. Delegates from California, Oregon, Washington, Idaho, Montana, Nevada and British Columbia, will be present. It is expected that more than 250 scientists will take part in the proceedings.

Delegates from California, Stanford, Oregon, Idaho, Washington and Southern California universities, California Institute of Technology, Scripps Institute, Oregon Agricultural College, Reed College and Washington State College have been asked to attend the research conferences, which are under the direction of the National Research Council.

Morning sessions the first two days, Thursday and Friday, June 17 and 18, will be devoted to meetings of the affiliated societies, the Western Society of Naturalists, Pacific Fisheries Society, American Physical Society, Astronomical Society of the Pacific, Cordilleran Section of the Geological Society of America, Pacific Coast branch of the Paleontological Society, American Phytopathological Society, San Francisco section of the American Mathematical Society, Seismological Society, American Chemical Society, Cooper Ornithological Club, Ecological Society of America, Society of American Foresters and Research Society.

The program includes registration, programs of the affiliated societies, a symposium on fisheries, Seattle automobile drives and welcoming addresses by President Henry Suzzallo and John C. Merriam, dean of faculties of the University of California, president of the Pacific Coast division of the American Association for the Advancement of Science and chairman of the states relations committee of the National Research Council. A Sigma Xi-Phi Beta Kappa lecture will be arranged for on Friday evening. Provision will be made for excursions to Rainier National Park and the Biological and Astronomical stations, Snoqualmie Falls and other points of interest, and a reception at the University of Washington last evening.

THE RESIGNATION OF THE DIRECTOR OF THE BUREAU OF MINES

DR. VAN H. MANNING, director of the Bureau of Mines, Department of the Interior, has tendered his resignation, effective on June 1, to President Wilson. Dr. Manning is leaving the government service to accept the position of director of research with the recently organized American Petroleum Institute, the most important body of petroleum men of the country.

In his letter to the President, Dr. Manning says:

> I hereby tender you my resignation, to take effect June 1, 1920, as director of the Bureau of Mines.
>
> It will be with reluctance and deep regret that I shall sever my connection with the Department of the Interior after thirty-four years of active service therein, and it is the opportunity of being able to continue in another capacity the work for the advancement of purposes fostered by the department that has been the chief factor in determining my decision to resign.
>
> I take this opportunity to express my sincere appreciation of the confidence that you have reposed in me as a public official and of the cordial cooperation of the departmental executives whom I have been able to serve. Especially I appreciate your constant help in my efforts to develop an organization that has at heart the welfare of the public, the advancement of the mineral industry, and the safety of the two million workers who contribute to the success of that industry.
>
> In leaving the government service there comes to me, as it has over and over again, the thought that although this government spends each year many millions of dollars in useful scientific work for the benefit of the whole people, the monetary recognition of its scientific and technical servants is not sufficient to enable them to continue in the service for the people. This has been especially true within the last few years when it has been impossible for many men to remain in the government service.

With the marvelous expansion of the industry of this country and the growing necessity of science to industry, the scientific bureaus have been utterly unable to hold their assistants against the competition of industry which is taking their highly trained men at salaries the government does not pay or even approach.

I feel very deeply that there ought to be more adequate compensation for the scientific and technical men in the government service so that none of them may be compelled to accept positions on the outside.

Many of these scientific men are of fine type for government work, care little for the commercial field, take an intense professional interest in their tasks and are of inestimable value to the government.

RESIGNATION OF PROFESSOR E. F. NICHOLS FROM THE YALE UNIVERSITY FACULTY

Announcement is made from Yale University that the resignation of Ernest Fox Nichols, Sc.D., LL.D., professor of physics, has been tendered and accepted. Professor Nichols has accepted the post of director of pure science in the Nela Research Laboratories of the National Lamp Works of the General Electric Company, at Cleveland, Ohio.

In offering his resignation Dr. Nichols wrote the following letter to the Yale corporation in explanation of the conditions which had led to his decision:

Sloane Laboratory,
Yale University,
New Haven, Connecticut,
April 21, 1920

The Corporation of Yale University.

Gentlemen: I have been offered the post of director of pure scence in the Nela Research Laboratories, National Lamp Works of the General Electric Company, at Cleveland, Ohio. The position offers complete freedom in the choice of research problems, and places at my unhampered disposal such human and material resources as no university I know of can at present afford.

I would like to accept this offer and therefore respectfully ask you to release me at the close of the present academic year from my post of professor of physics in Yale University.

The thought of leaving present colleagues and university surroundings is to me, in many ways, a source of deep regret, and I have hesitated long over my decision; yet the heightened opportunities of the new position are in everything else so advantageous that the offer becomes finally irresistible.

With appreciation and sincere regard,
Yours very truly,
Signed: Ernest Fox Nichols

Dr. Nichols went to Yale University in the fall of 1916 to occupy a new chair of physics, having resigned the presidency of Dartmouth College, in which capacity he had served since 1909, in order that he might have the desired opportunity to continue his scientific work. Professor Nichols is a graduate of the Kansas Agricultural College in the class of 1888, and has held professorships of physics in Colgate College, Dartmouth College and Columbia University. During the war from 1917 to 1919 he was absent from Yale University, to engage in research and development work for the navy.

THE ALLEGHENY OBSERVATORY

The following minute was adopted by the observatory committee and also by the executive committee of the board of trustees of the University of Pittsburgh at its meeting on January 14:

In complying with the request of Dr. Frank Schlesinger that he be relieved of his duties as director on April 1, 1920, to take charge of the Yale Observatory, the committee desire to express their appreciation of his fifteen years of active and fruitful service, during which the Allegheny Observatory has made many valuable contributions to astronomical science, and worthily upheld its international reputation created by Langley and Keeler. While we regret to lose the valuable cooperation and friendly personal relationship which our long association with Dr. Schlesinger has developed, we sincerely congratulate him on the enlarged and attractive field of scientific usefulness which his new position offers; and heartily wish for himself and family, continued health, happiness and success. Moreover, we look forward with pleasure to our continued cooperation in the solution of the great astronomical problems which are rapidly bringing into closer fellowship the astrophysicists of the world.

On the evening of March 22, a few days before Dr. Schlesinger's departure for New

Haven, a testimonial dinner was given to him by the observatory committee. Besides the committee there were present other members of the board of trustees and a few other guests.

Dr. H. D. Curtis has been elected director of the observatory and he is to assume charge early in July, 1920. Dr. Curtis has been connected with the Lick Observatory for about twenty years. For a number of years he had charge of the station of the Lick Observatory at Santiago, Chile; more recently he has had charge of the work with the Crossley Reflecting Telescope on Mount Hamilton.

Dr. Frank Craig Jordan, assistant professor at the Allegheny Observatory since 1908, has been promoted to a full professorship and has been elected assistant director of the observatory.

SCIENTIFIC NOTES AND NEWS

MEMBERS of the National Academy of Sciences have been elected as follows: Dr. James Rowland Angell, University of Chicago and the National Research Council, president-elect of the Carnegie Corporation, psychologist; Dr. Henry Prentiss Armsby, Pennsylvania State College, physiological chemist: Dr. Wilder D. Bancroft, Cornell University and the National Research Council, chemist; Dr. Hans F. Blichfeldt, Stanford University, mathematician; Dr. A. J. Carlson, University of Chicago, physiologist; Dr. William Duane, Harvard University, physicist; Dr. Lewis R. Jones, University of Wisconsin, plant pathologist; Dr. Elmer Peter Kohler, Harvard University, chemist; Dr. Charles K. Leith, University of Wisconsin, geologist; Dr. Clarence Erwin McClung, University of Pennsylvania and National Research Council, zoologist; Dr. Elmer V. McCollum, the Johns Hopkins University, physiological chemist; Dr. George Washington Pierce, Harvard University, physicist; Harris J. Ryan, Stanford University, electrical engineer; Dr. Joel Stebbins, University of Illinois, astronomer, and Dr. Bailey Willis, Stanford University, geologist. Arthur L. Day, of the Carnegie Institution, and T. H. Morgan, of Columbia University, were elected members of the council.

AT a meeting held April 20, the Academy of Natural Sciences of Philadelphia, in recognition of their scientific accomplishments, elected as correspondents the following: William Berryman Scott, Merrit L. Fernald, Hans Frederick Gadow, Johann P. Lotsy, Daniel T. MacDougal, Raymond Pearl, William E. Ritter, William Schaus and William Lutley Sclater.

DR. WILLIAM MORRIS DAVIS, emeritus professor of geology at Harvard University, has been awarded the Vega medal of the Swedish Anthropological and Geographical Society.

AT its last meeting the Rumford Committee of the American Academy of Arts and Sciences made the following appropriations for research: To Professor H. M. Randall, of the University of Michigan, in aid of his research on the structure of spectra in the infra-red, five hundred dollars; to Professor L. R. Ingersoll, of the University of Wisconsin, in aid of his research on the polarizing effect of diffraction gratings, one hundred and fifty dollars; to Professor A. G. Webster, of Clark University, in aid of his researches on new methods in pyrodynamics and practical interior ballistics, five hundred dollars.

PROFESSOR JACQUES HADAMARD, Sc.D., LL.D., of the Collège of France, is delivering at Yale University the thirteenth regular course of lectures on the Hepsa Ely Silliman Foundation. The first of M. Hadamard's lectures on "Some topics in linear partial differential equations" was given on April 23.

THE second series of the LeConte Memorial lectures will be given in the Yosemite National Park during the months of June and July. These lectures were instituted in honor of the naturalist and geologist, Joseph Le Conte, who for thirty years was a member of the faculty of the University of California. This year the speakers and subjects are announced as follows: Dr. John C. Merriam, "The philosophy of Joseph Le Conte"; Dr. A. C. Lawson, "The geological history of the Sierra Nevada"; Dr. Joseph Grinnell, "The vertebrate animals of

the Yosemite"; Dr. C. Hart Merriam, "Indian tribes formerly in Yosemite."

The University of Copenhagen has awarded the Salomonsen prize to Professor V. Ellermann for his work on leukemia in fowls. The fund for promotion of research on diabetes has been awarded to Dr. H. C. Hagedorn.

A preliminary committee has been formed to give to Sir George Thane, who recently resigned the chair of anatomy at University College, London, after forty-two years' service, some mark of the appreciation felt for him by his old pupils and colleagues. The intention is to ask Sir George Thane to sit for his portrait.

Claude Wakeland, deputy state entomologist of Colorado in charge of the alfalfa weevil investigation during the three years 1917–19, has accepted the position of state extension entomologist with the University of Idaho. Mr. Wakeland's permanent headquarters will be at Boise.

Dr. David Klein has resigned as associate professor of biochemistry in the Johns Hopkins University School of Public Health and Hygiene, and has taken a position with the Hollister Wilson Laboratories, Chicago, Ill., as director of research and control laboratories.

Ernest Jenkins Hoffman, who recently resigned as assistant chemist, U. S. Bureau of Mines, Pittsburgh, Pa., has accepted a position in organic research with W. B. Pratt, Inc., Boston, Mass.

Fixing their base of scientific operations in Death Valley at a level of 178 feet below the sea at the mouth of Furnace Creek Canyon which issues from the Funeral Mountains, Dr. Francis B. Sumner, associate professor and biologist in the Scripps Institute for Biological Research, and Joseph Grinnell, professor of zoology and director of the University of California Museum of Vertebrate Zoology, are now making special studies upon the mammals and birds of Death Valley. The expenses of the expedition are being defrayed from a special fund provided for the purpose by Mr. E. W. Scripps.

Neil M. Judd, curator of American archeology in the U. S. National Museum, left for northwestern Arizona on May 1 to continue his archeological investigations of the region north and west of the Rio Colorado. It is expected that a report on the prehistoric remains of this section of the southwest, covering researches of the past five years, will follow this season's work. At the request of the National Geographical Society, the secretary of the Smithsonian Institution has granted permission for Mr. Judd to direct the society's archeological reconnaissance of the Chaco Canyon region in New Mexico.

While returning from the recent meeting of the American Chemical Society at St. Louis, Dr. J. H. Ransom, director of chemical research at the Michigan Smelting and Refining Co., Detroit, Mich., stopped off at Purdue University and delivered a lecture on Non-Ferrous Alloys before the students of the school of chemical engineering. Dr. Ransom was formerly professor of general chemistry in this university.

It is requested that any material or facts of interest which will aid in the construction of a biographical memoir of the life and work of Henry Lord Wheeler, be mailed to Professor Treat B. Johnson, of Yale University, who is preparing a memoir of Professor Wheeler for the National Academy of Sciences.

The autumn meeting of the American Chemical Society will be held in Chicago from September 7 to 10, inclusive.

A special meeting of the Colorado Academy of Sciences which is the natural history section of the State Historical and Natural History Society of Colorado, was held at the State Museum, Denver, on April 2, when the following program was presented:

Work done and work that should be done by—

1. The Office of the State Forester, W. J. Morrill, state forester, Ft. Collins, Colo.
2. The Office of the State Geologist, R. D. George, state geologist, Boulder, Colorado.
3. The Office of the State Entomologist, C. P. Gillette, state entomologist, Fort Collins, Colo.

The annual convention of Sigma Gamma

Epsilon, the national undergraduate fraternity devoted to mining and geology, was held at Columbia, Missouri, on April 2 and 3. The fraternity passed resolutions urging the taking of steps to eliminate the fake mining engineer and geologist and offering its assistance to that end. A chapter of the fraternity is to be shortly installed in the University of Texas.

THE University of Arizona through the Arizona Bureau of Mines will this year conduct its annual field course in geology and mining for advanced students in the Dos Cabezas Mountains in southeastern Arizona. The region selected is one of complex and highly diversified geology, and several different types of ore deposits are under active development there. The party will enter the field on July 1, and will remain in camp for eight weeks.

PROFESSOR DAYTON C. MILLER, of the Case School of Applied Science, lectured under the auspices of the Research Committee of Oberlin College on April 14, on "Scientific Research at an army post."

PROFESSOR DOUGLAS JOHNSON, of Columbia University, addressed the Women's Canadian Club of Montreal, on March 19, on "The influence of topography on the war"; and a joint meeting of the Men's Canadian Club and the Women's Canadian Club of Quebec, on March 20, on "Geographic problems of the Peace Conference."

PROFESSOR MAX MASON, of the University of Wisconsin, lectured on April 7 and 8 before the department of mathematics and physics of the University of Iowa on the "Einstein theory of gravitation." He gave also a general lecture on "Methods used for the detection of submarines." Professor Mason is the inventor of apparatus for the detection of submarines.

DR. H. J. WHEELER, of Boston, recently addressed the agricultural faculty and graduate students in agriculture of the University of Minnesota on "The effect of crops upon those which follow," giving a summary of his earliest work on this subject in Rhode Island and of the continuation of it by Hartwell and Pember.

AT the Royal Geographical Society on March 17, Sir Ernest Shackleton gave an account of the geographical and scientific results of the 1914–1917 Antarctic Expedition.

DR. GEO. F. FREEMAN, botanist of the Société Sultanienne Agriculture, gave a lecture before the Cairo Scientific Society, April 1, on "The origin of agricultural plants."

THE New York Academy of Medicine held a memorial meeting in honor of the late Dr. Abraham Jacobi's ninetieth birthday anniversary on May 6. A bas-relief of Dr. Jacobi was presented by George McAneny and was accepted by the president of the academy, Dr. George David Stewart. The principal address was delivered by Dr. George E. Vincent, of the Rockefeller Foundation.

AT an International Conference of Red Cross Societies, held at Washington in 1912, it was decided to establish a medal both as a memorial to Florence Nightingale and to give international recognition to outstanding work by trained nurses in all parts of the world. Owing to the outbreak of the war in 1914, the first awards of this medal were postponed; but it is announced that it is intended to award fifty of these medals in January, 1920. The medal is in silver and enamel, consisting of a portrait of Florence Nightingale, "The Lady with the Lamp," with the words "Ad memoriam Florence Nightingale 1820–1910." On the reverse, surrounding a space reserved for the name of the recipient, is the inscription: "Pro vera misericordia et cara humanitate perennis decor universalis." The medal is attached to a white and red ribbon, on which is displayed a laurel wreath in green enamel surrounding a red cross on a white ground.

MR. CHARLES EDWARD GROVES, F.R.S., editor of the *Journal* of the London Chemical Society from 1884–1899, and vice-president of the society from 1899–1902, who died on February 1, aged 79, has left £10,000 to the Royal Institution for the "Groves Endowment Fund" for the promotion of scientific research, to take effect on the death of the last surviving member of his family.

The Lake Laboratory, which is now permanently located at Put-in-Bay on Lake Erie, will open for the summer of 1920 on June 21. Its facilities will be available for investigators until the middle of August. Courses for students in both plant and animal ecology, entomology, the structure of fresh-water vertebrates, and in icthyology will be conducted until August 1. The staff will be composed of Professor R. C. Osborn, director, Dr. F. H. Krecker, acting director, Professor S. R. Williams, of Miami University, Professor M. E. Stickney, of Dennison University, and Dr. C. H. Kennedy, of the Ohio State University. Some studies on fisheries problems were carried on last year and others are to be started during the coming session. It is desired to have the laboratory as well supplied as possible with recent biological literature and therefore investigators will be of direct service to the laboratory by including it in their mailing list. All reprints of such articles and all correspondence should be addressed to the Lake Laboratory, Ohio State University, Columbus, Ohio.

UNIVERSITY AND EDUCATIONAL NEWS

A bill recently passed by the Maryland legislature combines the Maryland State College of Agriculture with the University of Maryland School of Medicine under the name of the University of Maryland. The legislature appropriated $42,500, each year, for the medical school for the next two years and in addition appropriated $186,476 for the other departments of the university for 1921, and $165,416 for 1922. An appropriation of $203,000 was made for buildings and equipment.

Dr. William H. Nichols, of the General Chemical Company, has given $100,000 toward the endowment fund of New York University.

It is planned to erect a new chemistry building at Dartmouth College, which will involve an expenditure of about $350,000. Construction will be begun immediately.

The board of trustees of the College of the City of New York has authorized the granting of degrees of chemical, civil, electrical, and mechanical engineer on the satisfactory completion of a curriculum requiring five years. The announcement of the details of the curricula will shortly be issued. This is one of the steps taken by the College of the City of New York in the direction of closer cooperation between industry and colleges and colleges and universities.

Assistant Professor George E. Nichols, of Yale University, has been appointed to the teaching staff of the University of Michigan Biological Station for the coming summer session.

DISCUSSION AND CORRESPONDENCE

SINGING SANDS

Professor Richardson's recent article about "Singing Sands" of Lake Michigan, suggests to me that in analyzing the beach sands the students may have taken needless trouble, for the cause is certainly not dependent on their composition.

The fascinating pages of Marco Polo have numerous references to this phenomena, more or less exaggerated and tinged with superstition, and many travelers have discussed and some scientists have studied it.

A volume by Hanns Vischer confirms the previous statements of Commandant Gadel, Concerning the "voice of the mountain" near the oasis of Bilma, he, Vischer, says:

> There is a dark and forbidding rock frowning over Bilma near the southern end of the oasis. This mountain warns the inhabitants of the approaching arrival of a caravan; when it "sings" the men then know that a caravan is close at hand. The noise is produced by the blowing of the wind from a certain direction through crevices of the torn rock.

Says Gadel:

> On the sixth of October in the morning, the old Liman came to tell me that the mountain had spoken. On the eighth of October, at ten in the morning, the first Asbin caravan arrived, consisting of 4,851 camels and 857 men. The mountain had not lied.

There is every probability that Mr. Vischer is mistaken in his guess that the sounds are made by the blowing of the wind through a crevice in the rock, as will be seen by a general consideration of the subject, before I attempt to set forth the *probable* scientific explanation of the phenomenon. It is not confined by any means to the Sahara, or for that matter to desert places.

Near the coast of one of the Hawaiian Islands is an old graveyard. The winds blow ceaselessly across its barren expanse and it is fast being buried by *coral* sands. Passing fisher boats give this shore a wide berth, for when the wind is right, there arises from the white expanse a strange wail, like the howl of a dog, which is attributed to the restless spirits of the departed.

On the coast of Lower California, there is a locality which emits, at times, a bell-like sound. Here too the winds have piled up fine sand, and the peons declare that under its mounds lie buried the ruins of a convent, the bells of which toll with muffled tones, at the hour of prayer.

The infrequent traveler in the region of Mt. Sinai, camping at the mouth of the Wady el Dér, sometimes hears at sunset, a deep musical, booming sound, descending from the heights above. It is the great wooden gong of a monastery, perched upon the cliff. Such a gong is common in Arabia and is named a "Nagous." On the borders of the Isthmus of Suez stands a hill known as "Jebel Nagous"; that is, the Mountain of the Gong. The Arabs tell of weird sounds heard at this mountain—in storms, loud and wild, audible from a distance; in more quiet weather, low and musical. Jebel Nagous is alluded to in the "Arabian Nights." The American scientist, the late Dr. H. Carrington Bolton, some years before his death, organized an expedition to visit the mountain. After four days' journey from Tor, they went into camp at the base of the hill, which was found to be about 950 feet high. Dr. Bolton heard the music—a song of several notes, rising and falling, with one continuous deep undertone, like an organ note, and was able to ascertain the cause. Here, as in the other places named above, it is due to singing sands. The winds continuously blow this sand up against the sides of the hill, and impelled by the wind, it rushes up the slopes, emitting a multitude of tiny, tinkling notes, which when combined, make a considerable volume of sound. Then, just as the waves of the sea driven up the beach, rush downwards again, so the sand blown up the steep incline continually slides back, the angle of rest being about thirty-one degrees. It is the returning flow that gives out the steady undertone, increased by the echo from a sandstone cliff, and varying with the ever-changing wind.

What are singing sands? Every one has noticed the musical note made by the runners of a sleigh on a cold, clear night, which is caused by the impact of the snow or ice particles upon each other under the pressure of the vehicle. No ear could detect the sound made by *two* ice crystals, but when this is multiplied a thousand-fold, the combined effect is that of an instrument of music, playing one rather shrill note. Something of the kind is observed on parts of many sea beaches or other sand deposits; when they are walked upon, they give forth a note which varies with the locality. Ordinary "singing beaches" or "musical sands" are rather common, and the phenomenon has often been described and scientifically studied. The sounds are usually like the musical note which may be evoked when the wetted finger is rubbed around the edge of a glass bowl. Up to 1908, seventy-four localities had been noted in this country and eighteen abroad. In spite of this study, the true cause of the phenomenon is not yet certainly understood. It does not seem to make any difference whether the sands have been formed from crystalline or amorphous rocks. They differ widely in different localities in their mineralogical constituents, yet on the same beach, one place will give out a sound when disturbed, while another, a few yards away, is silent though apparently identical in structure. The property may be quickly lost or may be retained for months. When the sand is kept in a paper bag, its quality is best preserved; shaking in a

tin or glass receptacle quickly dissipates it; once lost, it can not be restored. Observers have been able to detect the sound from a New England beach sand over 400 feet away, when a small bagful is suddenly shaken.

While the analogy to the snow crystals may account for part of the phenomenon in some cases, it can not account for the singing of limestone, coral or other non-crystalline sands. Moreover, when one walks barefooted on musical sands, or runs the hand through them, there is felt a distinct tingling sensation. To some, this has suggested an electrical property. The latest and most plausible theory is that upon clean, dry sands, atmospheric gases condense, just as gases will adhere to particles of some metallic minerals and not others, and that the sounds and the sensations described are due to the disturbance of these air cushions. At any rate, the sensation experienced when walking barefoot through a patch of musical sand is very similar to that felt when the hand is immersed in a solution in which nascent oxygen is being generated.

By the way, I wonder if it has ever occurred to any archeologist that a possible explanation of the "Vocal Memnon" which Strabo and other travelers attested some two thousand years ago, might be the presence near the colossi, of musical sands, long since buried by the drift from the Libyan Desert.

Albert R. Ledoux

MODERN INTERPRETATIONS OF DIFFERENTIALS

To the Editor of Science: Professor E. V. Huntington, in an article entitled "Modern Interpretation of Differentials" (Science, March 26), states with reference to the definition lim $\Delta y = 0$, lim $N\Delta y = dy$, that, "The inevitable consequence of such a definition is that $dy = 0$, which is futile." Every school boy in the theory of limits knows that this is not true when N varies.

To take his figure of a graph of a function $y = f(x)$, it is logically correct to denote a point on the graph by $P(x, y)$ without subscripts, and $P'(x + \Delta x, y + \Delta y)$ is any other point on the graph, where $PQ = \Delta x$, $QP' = \Delta y$. Produce PQ to $PR' = N\Delta x = \Delta' x$, and draw $R'S' = N\Delta y = \Delta' y$, parallel to OY. Then $S'(x + \Delta' x, y + \Delta' y)$ is any point on the produced chord PP' (*i. e., variation in the same ratio is along the chord*).

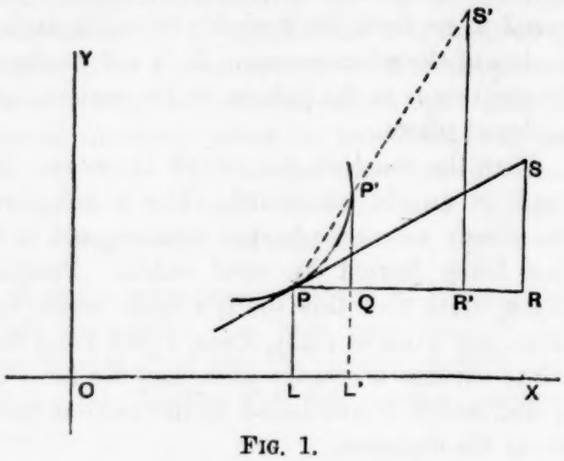

Fig. 1.

Professor Huntington asserts that $S'(x + \Delta' x, y + \Delta' y)$ inevitably approaches coincidence with $P(x, y)$ when Δx, Δy, approach zero, although it is obvious that it may, if N increase appropriately, approach any chosen point $S(x + dx, y + dy)$ *on the tangent at* $P(x, y)$, so that lim $\Delta' x = dx$, lim $\Delta' y = dy$. *Variation in the first ratio is therefore upon the tangent.*

Professor Huntington should also have investigated the historical questions involved before venturing to assert that the above theory of differentials "would prove highly misleading to the modern student." It is a sad commentary on the present state of the calculus in respect to its fundamental ideas, when we note the variety of explanations of these ideas by authors with little historical knowledge, all of whom, no doubt, would term their productions "modern," though most explanations will be found to date back several centuries, if they be anything more than vaporizing.

Sir William Rowan Hamilton in his Elements of Quaternions (Bk. III., p. 392) states that ordinary definitions by derivative methods do not apply in quaternions, and that after a careful examination of the Principia, he would formulate and adopt Newton's definition as follows:

Simultaneous Differentials (or *Corresponding Fluxions*) are *Limits of Equimultiples of Simultaneous and Decreasing Differences.*

As we have seen, Newton also made this definition in "Quadrature of Curves," essentially as Hamilton gathered it from the "Principia." Many better mathematicians than myself, or than Professor Huntington, have, in fact, examined this definition carefully, and have found it to be rigorous, simple, and of great generality.

The infinitesimal method of Leibniz is to be found essentially in Newton's first tract "De analysi per aequationen . . .," which Newton himself later rejected as illogical. A third method of explanation is that of Lagrange, which consists in assuming (for independent variables), $dx = \Delta x$, $dy = \Delta y$, and for a dependent variable z $dz =$ *principle part of* Δz, which Lagrange proposed to determine as *the terms of first degree in the expansion of* $z + \Delta z$ *in ascending powers of* Δx, Δy. Newton's dz is the same, if we put $dx = \Delta x$, $dy = \Delta y$. The adoption of the derivative method, led to devices to obtain the same significance of dz by derivatives, without assuming expansions in series. These involve various logical difficulties, especially when there are several independent variables. Also the differentials appear to change their values by changing the independent variables, whereas, Newton's method shows that for every equation between the variables, there exists (if differentiation be possible) a definite corresponding equation between their differentials, irrespective of the choice of independent variables.

Unquestionably, there has been a long continued propaganda, fostered at bottom to protect the claims of Leibniz, and aided by the inertia of established usage, to keep the methods of Newton in abeyance. Imagine, if the nationalities of these men had been reversed, the number of pamphlets that would have exploited the matter, and the number of textbooks in that method which would years ago have been published.

ARTHUR S. HATHAWAY
ROSE POLYTECHNIC INSTITUTE

CARBON DIOXIDE AND INCREASED CROP PRODUCTION

TO THE EDITOR OF SCIENCE: In 1912, at the International Congress of Chemists held in New York, Professor Ciamician, of the University of Bologna, presented a paper on the "Photochemistry of the Future," in which, among other things, the suggestion was made that crop production might be increased by increasing the concentration of carbon dioxide in the air. Of course, the idea underlying such a suggestion is that since the carbon dioxide of the air is a necessary constituent in the synthesis of carbohydrate by the plant, and since, furthermore, the percentage of the gas in the air is comparatively small, any increase in the amount of carbon dioxide may tend to increase the amount of carbohydrate produced.

That such is actually the case has been found by a number of German chemists, according to the Berlin correspondent of the *N. Y. Tribune* (April 4). Working in greenhouses attached to one of the large iron companies in Essen, and utilizing the carbon dioxide (freed from impurities) obtained from the blast furnaces, the yield of tomatoes was increased 175 per cent. and cucumbers 70 per cent. Further experiments in the open air, on plots around which punctured tubes were laid, and through the latter of which the carbon dioxide was sent, gave increases of 150 per cent. in the yield of spinach, 140 per cent. with tomatoes and 100 per cent. with barley.

BENJAMIN HARROW

STRUCTURAL BLUE IN SNOW

TO THE EDITOR OF SCIENCE: The recent blizzard began here with a heavy downpour of rain on the evening of March 5, which later turned into a glistening snow that was shattered by the furious wind and formed a crystalline-looking glittering coherent mass whose structure was maintained by the low temperature (about 20° F.).

When the sun finally came out on Saturday afternoon, I noticed that the shadows of the trees and the shadow masses of the distant snow, appeared unusually *blue*, and that the

snow itself looked blue-white, like paper or sugar "blued" with ultra marine. Evidently the snow, because of its structure, reflected a larger proportion of the short wave-lengths of blue; and we have here another illustration of a structural blue color, which, according to Wilder D. Bancroft "may be obtained when we have finely divided particles of liquid or solid suspended in a gaseous medium (blue of the sky) or a liquid medium (blue of the eye or of the tree-toad); or when we have finally divided air-bubbles suspended in a liquid or solid medium (blue feathers).[1]

Incidentally there is some justification for the somewhat brilliant blues used by the artists in painting snow scenes, especially in the shadows; and we recall the story told of Whistler, who, when a lady visitor at his exhibition remarked, "I've never seen a sunset like that, Mr. Whistler," promptly replied, "Well don't you wish you could?"

Jerome Alexander

Ridgefield, Conn.

SCIENTIFIC BOOKS

How to Make and Use Graphic Charts. By Allan C. Haskell, B.S., with an introduction by Richard T. Dana. 539 pages. First edition. Price $5.00.

The last years have seen a tremendous progress in the application of graphic methods and while these methods must be regarded as means rather than as ends they nevertheless play a most important part of scientific analysis.

To most persons except the trained engineer, biologist or statistician the principles of analytic geometry which are the basis of most graphic methods appear too difficult and intricate as that they would be used for practical problems of every-day life.

Mr. Haskell's book fills therefore a distinct demand when it contributes to a clear understanding and wider application and recognition of the graphic method. The treatment is written from the standpoint of the practical engineer who comes daily in contact with such problems which will lend themselves to the application of this form of analysis.

The 539 pages of the richly illustrated book are divided into 18 chapters which go exhaustively into every phase and detail of the possibilities and applications of graphic analysis. Special consideration is given to the current engineering problems of to-day. One whole chapter is devoted to the nomographic or alignment chart. This subject is treated in Chapter VIII. and taken up again in Chapter XVI., "Computation, arithmetical and geometrical" which devotes some thirty pages to this interesting subject.

The author deserves much praise for faithfully collecting the manifold material on this subject. On page 348 however I think it would be worth while to mention the graphic calculation of the polytropic curve based on the equation

$$(1 + tg\beta) = (1 + tg\alpha)^n.$$

The lack of space prevents a longer explanation but for the rapid design of isothermal and adiabatic curves in connection with combustion engine design, this method[1] is extremely valuable on account of its accuracy, rapidity and range covering all exponents $n = 1.10$ (isothermal) to 1.41 (adiabatic).

Chapter VII. would have had room for the smelting diagrams of Stead and Saklatwalla[2] and of Shepherd.

Chapter XVII. is devoted to the graphic methods of designing and estimating. The civil engineer will find much of value and interest here. I think however the chapter could be extended to the advantage of the mechanical engineer and his problems.

The wealth of references relating to the graphic methods which are given at the end of each chapter and which have been collected by Mr. Haskell make the book valuable as a source of information, in short the author has responded to a vital demand for a practical book, "How to make and use graphic charts." The practical man will find much material ready for use and easily understandable and

[1] See "The Colors of Colloids," VII., *J. Phys. Chem.*, Vol. 23, pp. 365–414.

[1] E. Braner, *Z. d. v. d.*, I., 1885, p. 433.

[2] *Journal of the Iron and Steel Institute*, 1908, No. 11, p. 92.

the scientist much inspiration for further research and investigation. R. VON HUHN

NEW YORK

SPECIAL ARTICLES

THE HEREDITY OF SUSCEPTIBILITY TO A TRANSPLANTABLE SARCOMA (J. W. B.) OF THE JAPANESE WALTZING MOUSE

IN 1916[1] the writer in collaboration with Tyzzer reported on the inheritance of susceptibility to a transplantable carcinoma (J. W. A.) of the Japanese waltzing mouse. This tumor grew in one hundred per cent. of the Japanese waltzing mice inoculated and in zero per cent. of the common non-waltzing mice. When these two races were crossed, the F_1 generation hybrids showed sixty-one out of sixty-two mice to be susceptible. In these mice growth was as rapid if not more so than in the Japanese waltzing mice themselves. The one exception may well have been due to faulty technique for a reinoculation test was not made.

The F_2 generation gave a very interesting result—only three out of 183 mice grew the tumor. At that time the results were explained on the basis of multiple Mendelizing factors[2] whose number was estimated at from twelve to fourteen. *Simultaneous presence* of these factors, themselves introduced by the Japanese waltzing race, was considered necessary for progressive growth of the tumor. The analogy between this case and that of coat color in wild mice, dependent upon the simultaneous presence of at least five known Mendelizing factors was at that time pointed out.

Later[3] while working with a transplantable sarcoma (J. W. B.) of the Japanese waltzing mouse, results were obtained which showed what semed to be a somewhat simpler quantitative condition of the same process. In this case, the parent races and F_1 hybrids behaved as before, but the F_2 hybrids gave a total of twenty-three susceptible, to sixty-six non-susceptible animals. It was previously estimated that from five to seven factors were involved. In order to determine more closely the number of factors, new experiments were devised as follows: F_1 hybrid mice themselves susceptible were crossed back with the non-susceptible parent race. This has recently given a back cross generation whose susceptibility would depend upon the factors introduced through the gametes received from their F_1 parent. If one factor was involved, the ratio of gametes containing it formed by the F_1 animal, to those lacking it would be 1:1, if two factors, 1:3; if three factors 1:7; if four factors, 1:15; if five factors, 1:31; if six factors, 1:63; and if seven factors, 1:127. Susceptible and non-susceptible *individuals* would occur in the back cross generation in similar proportions.

The actual numbers obtained were twenty one susceptible to 208 non-susceptible. This result may be compared with expectations on three, four, five, and seven factor hypotheses, as follows:

	Susceptible	Non-susceptible	Ratio
Expected 3 factor....	28	201	1:7
Observed	21	208	1:90
Expected 4 factor....	14	215	1:15
Expected 5 factor....	7	222	1:31
Expected 7 factor....	1.8	227.2	1:127

The observed figures fall between the three and four factor hypothesis. The numbers are not large enough to give a definite test, but the F_2 generation already mentioned is interesting as a supporting line of evidence. If we compare this with the expectation, we find that the observed figures lie between the four and five factor hypothesis. In both cases the four factor hypothesis figures are close and the three and five factor hypothesis

	Susceptible	Non-susceptible	Ratio
Expected 3 factor....	39	50	1:1.3
Expected 4 factor....	29	60	1:2.1
Observed	23	66	1:2.8
Expected 5 factor....	21	68	1:3.2

[1] Little, C. C., and Tyzzer, E. E., 1916, *Jour. Med. Research*, 33: 393.

[2] Little, C. C., SCIENCE, N. S., 1914, 40, 904.

[3] Tyzzer, E. E., and Little, C. C., 1916, *Jour. Cancer Research*, 1: 387, 388.

are to be still considered as possibilities, though not probabilities. The six and seven factor hypotheses appear to be definitely eliminated.

The non-susceptible back cross animals which should by the multiple factor hypothesis contain in many cases part, but not all, of the factors for susceptibility are being tested by breeding back with the F_1 animals. If four factors are involved, as seems likely, of every fifteen such back cross animals approximately four or 26.6 per cent. should have three; six or 40 per cent. two; four or 26.6 per cent. one; and one or 6.6 per cent. none of the four factors necessary for continued growth of the tumor. When crossed with F_1 animals these back cross types should give the following ratios of susceptible to non-susceptible animals in their progeny.

Type of Back Cross	Ratio of Susceptible to Non-Susceptible Progeny
Having three factors	1: 3.7
" two factors	1: 6.1
" one factor	1: 9.7
" zero factors	1: 15

The first two categories should be easily recognizable and together form 66.7 per cent. of the back cross animals. Such tests have now been begun.

The sex chromosome has been eliminated as a probable carrier of any of the four factors as follows. If mice like other mammals have the female XX and the male XY in formula, the use of susceptible Japanese waltzing males to form the F_1 animals used, gives daughters carrying his X, and sons his Y chromosome. If now his *sons* only are used to produce the back cross generation by mating with common non-susceptible females, all the X chromosomes in the resulting animals will be derived from common non-susceptible mice. Unless therefore, crossing over between the X and Y chromosomes occurs frequently, any susceptibility factor borne in the X chromosomes of the original Japanese waltzing males used, has been eliminated.

While further investigations are in progress, we may conclude provisionally that:

1. From three to five factors—probably four—are involved in determining susceptibility to the mouse sarcoma J. W. B.

2. That for susceptibility the simultaneous presence of these factors is necessary.

3. That none of these factors is carried in the sex (X) chromosome.

4. That these factors Mendelize independently of one another.

C. C. Little

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

The fifth annual meeting of the American Association of Petroleum Geologists was held in Dallas, Texas, March 18 to 20, with headquarters at the Adolphus Hotel. The annual meeting of 1919 also was held there, and Dallas was selected for a second time because of its accessibility to the southwestern oil fields, where large numbers of members are now working. Almost three hundred members and more than a hundred visitors were registered from all parts of the United States. The association was honored by the presence of Dr. George Otis Smith, director of the United States Geological Survey, who was made an honorary member of the association. Other distinguished members present from a distance were R. P. McLaughlin, oil and gas inspector of California; Dr. Ralph Arnold, consulting geologist, of San Francisco, New York and London; Professor Roswell H. Johnson, of Pittsburgh; and Everett DeGolyer and Donald F. McDonald, of New York.

The opening session was called to order by President I. C. White, state geologist of West Virginia, well known as the father of the anticlinal theory. Greetings were given by a representative of the Oil Development Committee of the Chamber of Commerce of Dallas, and by Robert H. Hill, president of the Southwestern Geological Society, and responded to by President White.

The general subject of this session was New Mexico and Northwestern Texas. Papers were given by Dr. John K. Knox, on "The geology of New Mexico as an index of probable oil resources," by Dan L. Garrett on "The stratigraphy of northeastern New Mexico"; by Wallace G. Matteson on the "Oil possibilities of northeastern New Mexico," and by Dr. Chas. N. Gould on "Types of structure at Amarillo, Texas."

The Thursday afternoon session was devoted to a consideration of the Louisiana and Texas fields, and papers were given by Chester A. Hammill on "The structure of northwest Louisiana"; by Sid-

ney Powers on "The Sabine uplift," and by Dr. Irving Perrine on "Some problems of the Louisiana oil fields." A paper on "The geological structure of Eastland and Stephens counties, Texas," was read by H. H. Adams, one of the "Position of the Ellenberger formation in north central Texas"; by Dr. E. H. Sellards, and one on "Unconformities in the Texan Permian," by Dr. J. W. Beede. A paper by Dr. J. A. Udden, director of the Texas Bureau of Economic Geology, on "Suggestions of a new method of making underground observations," was read by Dr. Sellards.

On Thursday evening a public meeting was held in the City Temple, and the citizens of Dallas had the privilege of hearing Dr. George Otis Smith, director of the United States Geological Survey, in a lecture on "The public service opportunity of the oil geologist." Dr. Smith emphasized the responsibility of the oil geologist as a public servant and educator, and held that while it is the first duty of the oil geologist to find the oil, it is no less his duty to see that it is protected from the effects of improper operations in its recovery, and to raise his voice against the practise of mining oil with total disregard of underground property rights. He urged that membership in the association should carry its guaranty of both professional ability and moral reliability. The lecture was followed by an informal reception and smoker, to give members and visitors an opportunity to meet Dr. Smith.

A technical session was held in the municipal auditorium Friday morning, and most of the papers were illustrated by figures and diagrams. Dr. E. A. Stephenson and H. R. Bennett had prepared diagrams showing the decline of the Ranger oil field, and Glenn H. Alvey gave "Decline curve predictions." Papers were read by Charles V. Millikan on "The interrelation of the folds of Osage county, Oklahoma; J. L. Tweedy gave "A criticism of the 10 to 1 increase in Barrel Day prices"; and Professor Roswell H. Johnson and Alden W. Foster one on "Barrel Day" versus "One Day costs." Professor Johnson also gave a paper on "The cementation process in sandstone." A summary of the work of the California State Mining Bureau in petroleum and gas was given by R. P. McLaughlin. Mr. McLaughlin brought to the convention a very interesting model of a California oil field. This model was described and illustrated in the *Literary Digest* of February 28, 1920.

Friday afternoon was given to a consideration of the Kansas and Oklahoma fields. Dr. Eliot Blackwelder gave "Origin of the domes of central Kansas," Dr. Raymond C. Moore and F. L. Martin "The relation of granite to oil production in Kansas," and Dr. Moore and Dr. Winthrop P. Haynes "The outcrop of basic igneous rock in north central Kansas." Dr. J. W. Merritt's subject was: "Pennsylvania sedimentation around Healdton Island, Oklahoma," and Fritz Aurin gave "Pre-Pennsylvanian oil and gas horizons in Kay county, Oklahoma." A paper on "New oil development in Oklahoma," was given by C. W. Shannon, state geologist of Oklahoma, at an earlier session.

A preliminary business meeting followed the Friday afternoon program. The reports of officers and committees were presented, new business introduced, and nominations made. The business session was concluded Saturday morning, and this was followed by a regional session which was carried over into the closing session on Saturday afternoon. A paper by David A. Reger on "Recent oil developments in West Virginia," was read by Ray V. Hennen, and "Notes on the Canadian foothills belt," by Wesley Purdy, was read by E. DeGolyer. F. W. DeWolf, state geologist of Illinois, gave one paper on "The new Trenton development," illustrating it by maps and diagrams, and one on the "Blue sky laws of Illinois," showing that laws are being enacted for the protection of the public against unscrupulous promoters. A paper on the "Development of oil and gas in Wyoming," was given by C. H. Wegemann. Dr. Edward Bloesch gave a résumé of "Petroleum investigations in Switzerland," showing that the drill would have to decide whether oil was present in commercial quantities.

The engineer's side of the petroleum problem was given by A. W. Ambrose, head of the Petroleum Experiment Station at Bartlesville, Oklahoma, in a paper on "The petroleum production engineer and his relation to future production." Mr. Ambrose said that by present processes only a small percentage of the oil is recovered, and emphasized the necessity of more effective methods. The last paper of the session and of the convention was one read by Earl A. Trager, who gave a résumé of "The oil shale industry, with an outline of methods of distillation." This is a subject that will be given more attention as the demand for oil increases and the supply from wells diminishes.

The following papers were read by title: "Types of structures in Chaves county, Texas," J. W. Merritt; "Problems of production and methods of solving them," T. E. Swigart; "Oil

shales of Wyoming,'' Professor E. F. Schramm; ''Recent oil developments in California,'' Robert B. Moran; ''Some geological problems in oil and gas recovery in Kentucky,'' W. R. Jillson; ''Probability of oil and gas in Montana,'' Professor J. P. Rowe. Prior to adjournment a vote of thanks was extended to the retiring president, Dr. I. C. White, and to the Dallas Chamber of Commerce and the Southwestern Geological Society, for courtesies during the convention. Invitations for the next annual meeting have been received from San Francisco, New York, St. Louis and Oklahoma City, and will be considered by the executive committee. The proceedings of the convention will be published as Volume IV. of the bulletin of the association.

The following officers were elected for the coming year: *President,* Wallace E. Pratt, chief geologist, Humble Oil Company, Fort Worth, Texas; *Vice-president,* Alex. W. McCoy, consulting geologist, Bartlesville, Oklahoma; *Secretary-Treasurer,* Charles E. Decker, associate professor, University of Oklahoma, Norman (reelected); *Editor,* Raymond C. Moore, state geologist of Kansas, University of Kansas, Lawrence, Kansas.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

MINUTES OF THE EXECUTIVE COMMITTEE OF THE COUNCIL

The meeting was called to order by the president at 5 P.M., on April 26, 1920, in the Board Room of the Cosmos Club, and Dr. Howard was elected chairman for the meeting. The following members were present: Cattell, Fairchild, Howard, Humphreys, Livingston, MacDougal, Osborn and Ward. Mr. Woodward, the treasurer, attended the first part of the meeting.

1. *Grants.*—A resolution was passed to the effect that appropriations made to the Grants Committee shall be limited to the calendar year for which made. At the end of that year they automatically revert to the Treasury. (The executive committee may, of course, take special action before the end of the year, in cases where reversions would occur. For the year 1920 the amount of one grant made in 1919 and not withdrawn had been added to the 1920 appropriation of the grants committee, making this appropriation $4,500 instead of $4,000.)

2. *Life Memberships.*—A recommendation of the treasurer was adopted, to the effect that the treasurer is to pay to the permanent secretary three dollars each year for each life-membership requiring a subscription to the journal. (This special action was called for by the fact that the income from the fifty-dollar life-memberships is not sufficient to pay for the journal at the present rate.) At the beginning of the treasurer's fiscal year, the permanent secretary is to inform the treasurer in regard to the number of subscriptions to the journal to be thus cared for.

3. *Remission of Dues in Arrears.*—A resolution was passed to the effect that all members whose accounts show arrearage in dues for the years 1917–1919 (3 years), 1918–1919 (2 years), and 1919 (1 year), be *reinstated* as if back dues had been paid in full, providing they pay the annual dues for 1920 before the end of the present fiscal year. (This action was taken on account of war conditions.)

4. *Moratorium for Members Residing in Continental Europe.*—A resolution was passed to the effect that members residing in continental Europe may retain membership and receive the journal on account for three years (1920, 1921 and 1922) if specifically requested. (The preceding resolution of course also applies in these cases.)

5. *Toronto Meeting (1921–1922).*—The permanent secretary was instructed to accept with appreciation the invitation of the University of Toronto and of the Royal Canadian Institute and that he notify the secretaries of sections, of divisions and of affiliated societies to the effect that the annual meeting for 1921–1922 will be held at the Christmas season in Toronto.

The meeting was adjourned at 6 o'clock, to convene again at 7 in the private dining room of the Cosmos Club.

The adjourned meeting was called to order by President Howard. The following members were present: Cattell, Fairchild, Howard, Humphreys, Livingston, MacDougal, Noyes, Osborn and Ward.

6. *Science News Service.*—Mr. MacDougal presented a report on the organization of the Science News Service, supported by Mr. E. W. Scripps.

7. *Representatives for Conference with Science News Service.*—At the request of the Science News Service a committee was appointed, which consisted of Messrs. Cattell, Humphreys and George T. Moore, to confer with three representatives of the National Academy and three representatives of the National Research Council, and with representatives of the Science News Service, in the organization and operation of that service.

8. *Minutes of Last Meeting.*—The minutes of the last meeting were read and approved.

9. *Action of Committee during Interim.*—Mr.

Cattell reported that the office of permanent secretary had been filled by an arrangement with Mr. Livingston to devote two days a week on the average to this work, dating from February 1, 1920. Arrangement was made by which Mr. Howard would help the new permanent secretary in taking up the work.

10. *Permanent Secretary's Report on the Office.*—The former assistant secretary resigned and took up a new position on April 1, 1920. Mr. Sam Woodley was appointed to take charge of the office beginning March 15, 1920. The permanent secretary was given authority to employ the title of executive assistant for Mr. Woodley.

The business affairs of the office were stated to be nearly up to date.

The financial statement of April 26, 1920, showed an apparent balance in the bank of $22,634.75. (There may be alterations in this to be made when the vouchers of the former permanent secretary become available.)

From the report on membership it appears that there were 2,238 members owing the association for dues for one, two or three years. (These arrearages are to be cancelled according to resolution stated above—No. 3.) There were 8,034 members paid up for 1920.

11. *Election of Sectional Officers.*—On nomination of the corresponding sectional committees, Dr. Eliot Blackwelder was elected vice-president of Section E (Geology), Dr. Frederick L. Hoffman was elected vice-president of Section K (Social and Economic Sciences), Dr. Edwin W. Allen was elected vice-president of Section O (Agricultural), and Dr. Frank N. Freeman was elected secretary of Section I (Psychology).

12. *Spring Meeting of this Committee in Future.*—It was decided that, in order to have more time and to avoid conflicts with other meetings, the 1921 spring meeting of this committee will be called for 12 o'clock noon on the Sunday preceding the meeting of the National Academy.

13. *Autumn Meeting of this Committee.*—It was decided that the next meeting of this committee will occur on Sunday, October 17, in New York, at a place to be designated later.

14. *Report on the Southwestern Division.*—Mr. MacDougal reported that the Southwestern Division had been organized. The geographic limits are to include all members of the association resident in the states of Arizona and New Mexico and in Texas west of the Pecos River. At the wish of those involved some members will be transferred from the Pacific to the Southwestern Division.

The Constitution and By-Laws of the Western Division are appended.

This report was adopted and the organization of the Southwestern Division was ratified by this committee.

Mr. MacDougal presented the applications of 23 new members, who were duly elected to membership.

Seventy-three names of members of the Southwestern Division were nominated for fellowships and were duly elected.

Mr. MacDougal called attention to the desire of the officers and members of the Southwestern Division to have lectures in their region delivered by scientists from other parts and requested that the permanent secretary notify the secretary of the Southwestern Division whenever it may appear convenient, basing this notification on such information as the permanent secretary may have from time to time. It is understood that the Southwestern Division will pay extra expenses incurred by lecturers.

15. *Applications for Affiliation.*—The application for the affiliation of the National Geography Teachers was favorably discussed, but final action was deferred until the next annual meeting.

On motion duly made and seconded the Society of Sigma Xi was affiliated with the association.

16. *Correction of Published List of Affiliated Societies.*—Attention was drawn to the fact that the Wilson Ornithological Club has been listed as an affiliated society, whereas it has never been affiliated. It will remain on the list as an associated society.

17. *Books for Promoting Good Citizenship.*—A request from the American Library Association asking that the A. A. A. S. aid in a movement aiming to provide suitable literature to help in the Americanization of immigrants was referred to the president and permanent secretary with power to determine whatever action seems to be feasible.

18. *Preservation of Natural Conditions.*—A request from Dr. Shelford, representing the Ecological Society, asking that the association appropriate funds to be used for the promotion of a project of the society on this subject, was discussed but it was decided that the association was unable at the present time to comply with this request.

19. *Collection of Portraits and Letters of Presidents, A. A. A. S.*—A proposal that the association purchase at a price of $300 a collection of 74 portraits and 74 autograph letters of all the presidents of the association to date (which is now in the possession of Dr. Marcus Benjamin) was favorably

discussed, but action was deferred until the next annual meeting.

20. *Committee on Bibliography of Science.*—The permanent secretary read a letter from the chairman of this committee, Dr. C. B. Davenport, in lieu of a formal report. No action was taken.

21. *Publication of Proceedings.*—Plans for the publication (membership list) were discussed and it was decided to ask all members for the information needed in the preparation of the next membership list, this request to be made at the time the statements for the 1921 dues are sent out. It was decided that members who remit $1 extra for the *Proceedings* before the book goes to press may receive it at this price. After the book goes to press the price is to be $1.50. The price to non-members is to be $1.50. It is planned to publish about March or April, 1921.

22. *Terms of Office of Members of this Committee.*—Attention was drawn to the fact that the terms of elected members of this committee elected at the St. Louis meeting, had not been determined. This matter was taken up and lots were drawn, giving the following terms of office:

For the year 1920: Mr. Osborn and Mr. MacDougal;

For the years 1920 and 1921: Mr. Flexner and Mr. Humphreys;

For the years 1920, 1921 and 1922: Mr. Cattell and Mr. Ward;

For the years 1920, 1921, 1922 and 1923: Mr. Noyes and Mr. Fairchild.

23. *Plans for Chicago Meeting.*—It was decided that the official period of the Chicago meeting shall be December 27, 1920, to January 1, 1921, inclusive. On motion duly made and seconded, it was decided that the next council meeting shall be called for Tuesday, December 28, at 2. The general session is scheduled for the evening of Tuesday, December 28.

It was emphasized that a strong campaign for new members in the Chicago region should be carried out before the meeting by the local committee.

24. *Interpretation of New Fiscal Year.*—It was decided that members joining the association may defer the beginning of their membership and the beginning of the subscription to the journal until the beginning of the next year, if they so specify at the time dues are paid. (This action seems desirable on account of the fact that members entering between the time of the annual meeting and the beginning of the next fiscal year—October 1—do not receive the privileges of any annual meeting if their dues are credited to the current fiscal year.)

25. *Election of Members under the New Constitution.*—On motion duly made and seconded the permanent secretary was authorized to employ a card method for handling applications for membership without the requirement of two sponsors which has hitherto been in effect. The permanent secretary was authorized to act as a sub-committee on the election of members to the association after proper application and remittances has been received.

26. *Election of Fellows.*—As stated above (No. 14), 73 fellows were elected from the Southwestern Division. Eighty-one fellows were elected from the American Society of Zoologists.

The procedure to be followed in the election of fellows under the provision of the new By-Laws (Art. II., Sec. 4) was discussed, and it was decided that the secretaries of the sections of the association shall furnish the permanent secretary with a list of nominations for fellowship, at least once each year, the data for this list having been obtained from the secretaries of the affiliated societies concerned.

27. *Affiliation of Societies.*—The permanent secretary was instructed to prepare a list of scientific societies that presumably should be affiliated with the association, but which are not now affiliated, to the end that the affiliation of these societies may be arranged.

28. *Affiliation of Academies.*—Mr. Ward presented a report on this subject.

29. *Office Equipment.*—The permanent secretary was authorized to proceed with the geographic classification of the members and other related projects.

The committee adjourned at 11.07 to meet in New York at 11 o'clock on October 17, 1920.

Burton E. Livingston,
Permanent Secretary

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